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(71) Applicant: INTEL CORPORATION [US/US]; 2200 Mission College Boulevard, Santa Clara, CA 95052 (US).

(72) Inventors: RICHARDSON, John; 2748 Northeast 19th Avenue, Portland, OR 97212 (US). SILVESTER, Kelan; 19840 N.W. Metolius Drive, Portland, OR 97229 (US). SHIMODA, Marion; 20045 S.W. Nancy Lane, Aloha, OR 97007 (US).

(74) Agent: TROP, Timothy; Trop, Pruner, Hu & Miles, P.C., Suite 100, 8554 Katy Freeway, Houston, TX 77024 (US).

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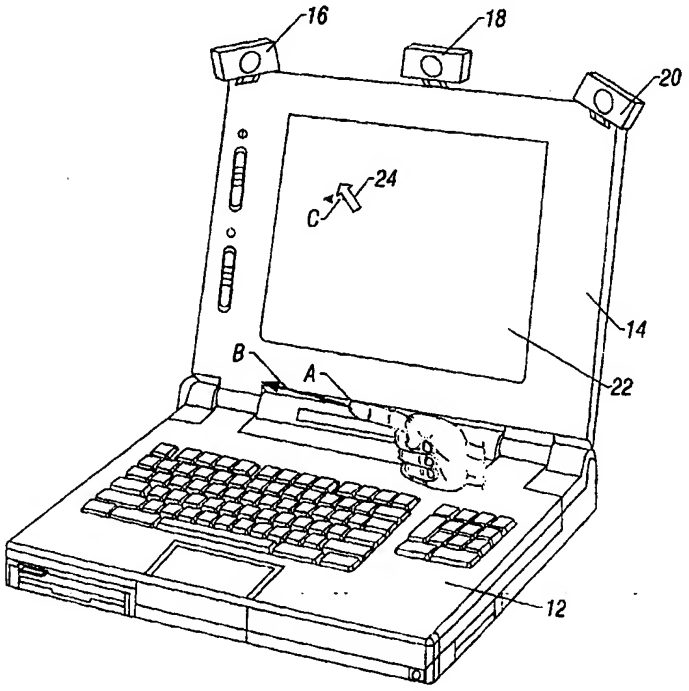
(54) Title: CONTROLLING A POINTER USING DIGITAL VIDEO

(57) Abstract

The position of a pointer (24) on a computer display (14) may be controlled using captured streaming video. One or more digital cameras (16, 18, 20) may record actions inputted by the user. The recorded images are analyzed using appropriate software (52), such as pattern recognition software, to detect a particular object shape which corresponds to a given cursor command. When this object shape is detected, its direction, extent and/or rate of movement may be analyzed. Information about the direction, extent and/or rate of movement of the object may then be used to control the position on the pointer on a display screen.



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Controlling A Pointer Using Digital Video

Background

This invention relates generally to computers and particularly to pointing devices which control the position of display pointers or cursors.

A variety of pointing devices have been used in computer systems to control the position of a pointer or cursor on a display screen. The pointer or cursor is an image that may be moved across the screen to select a particular option provided in the form of a physical depiction on a user interface. In this way, a user may interact with a video display to provide focus to particular tasks and activities offered through the user interface.

Well known pointing devices include the mouse, which is held in the hand and moved over a surface. Movements of the mouse result in corresponding movements of the pointer through a mouse interface which converts the mouse movements into pointer display control signals.

Another familiar pointing device is the track ball which is essentially an inverted mouse. The track ball is a rotary ball which can be moved by the user. Movements of the ball are sensed and result in corresponding movements of the pointer. Another known pointing device is the pointing stick which is provided in the middle of the keyboards of certain computers. The stick may be tilted to control the position of the pointer.

Touch pad pointing devices allow the user to touch a contact surface. Movements of the user's finger on the contact surface are tracked as corresponding movements of the pointer on the computer display. Normally touch pads have capacitive sensors which detect finger position and movement and translate this movement into pointer position control signals.

Existing pointing devices generally involve an electromechanical interface which is prone to failure. In addition, the interface may become fouled, resulting in incorrect signals which may cause the movement of the pointing device to be incorrectly reflected in the pointer position on a display. In many cases, the extent of available movement of the pointing device is limited, making it difficult to learn to control the pointer using the limited movements available through the pointing device.

Thus there is a need for an improved pointing device which overcomes the disadvantages inherent in the existing pointing devices.

Summary

In accordance with one embodiment, a method for enabling control of a computer pointer includes enabling a computer to receive a digital video stream. A way is provided to analyze the video stream. A connection is created that allows the analysis of the video stream to be used to control the pointer position.

Brief Description of the Drawings

Figure 1 is a side elevational view of one embodiment of the present invention;

Figure 2 is a perspective view of the embodiment shown in Figure 1;

Figure 3 is a block depiction of the embodiment shown in Figures 1 and 2;

Figure 4 is a diagram showing a method for implementing video control over pointer position;

Figure 5 is a flow diagram for software which may be used to control pointer position using one or more digital video cameras; and

Figures 6 and 7 are flow diagrams for calibration software.

Detailed Description

A computer system 10, shown in Figure 1, may include a keyboard base 12 and a display 14. The computer system 10 is illustrated as a portable computer system but other computer systems including desktop computer systems may be used in connection with the present invention as well.

A plurality of digital video cameras 16, 18 and 20, as shown in Figures 1 and 2, may be coupled to the computer system 10. For example the cameras may be mounted on the display 14. The cameras may capture images created by the user for the purpose of controlling the position of a pointer 24 on the screen 22 of the display 14.

For example, the user's hand A may assume a finger pointing position as shown in Figures 1 and 2. The hand A may be moved relative to the computer. The particular pattern of the pointed finger may be one which is recognized by software contained in the computer as indicating that pointer control is desired. The digital cameras 16, 18 and 20 may capture the image of the hand A and its movement, indicated by the arrow B, and may reflect that movement in corresponding movements of the pointer 24, indicated by the arrow C in Figure 2.

While the present invention has been illustrated with respect to a simple finger pointing embodiment, other captured images may be recognized by the computer system as pointer control inputs. For example, a closed hand, a pointer of some particular shape in the hand, and the orientation and movement of the user's face could all be recognized as pointer control commands as well. Also, the motion of an object may be used to indicate direction, speed and other information.

With additional semantic processing one could translate a motion into its underlying meaning. For example, a head nodding yes or shaking no could be translated into a button click of Yes or No (or OK or Cancel) when a dialog box is on the screen. Similarly, hand gestures like a "thumbs up" for Yes and a sharp wave of the hand for No could be used.

In this way, the pointer position may be controlled without requiring actual contact with the computer itself. This eliminates the necessity for electromechanical connections used with the mouse and other pointing devices. Thus, it may be possible to improve the accuracy of the translation of the input pointer control commands to pointer movement.

Referring now to Figure 3, an exemplary computer system 10 for implementing an embodiment of the present invention includes a processor 26 communicating with a bridge 28 and system memory 30. The bridge 28 may couple a bus 32 which in turn couples a display controller 34, a video interface 36 and another bridge 38. The display controller 34 may couple the display screen 22. The video interface 36 may provide a connection to the cameras 16, 18 and 20. The bridge 38 may couple another bus (not shown) and a hard disk drive 40 which may store a software program 52 thereon. The software programs 52, 78 and 79 may be loaded into the system memory and executed.

Referring to Figure 4, the ability to control the pointer position using digital video requires that the computer system be enabled to receive a digital video stream (block 72). In addition an ability to analyze the video stream (block 74) must be provided as well. Conventionally, this video analysis may involve well known pattern recognition algorithms which may be preprogrammed at the factory or may be implemented through learning software. The learning software allows the user to train the software to recognize a particular user's fingers, movements, or desired attributes and to recognize them as particular pointer control commands.

Next, the computer system may be provided with a connection (block 76) which allows the analysis of the video signal to be used to control pointer position. To this end,

there may be a suitable connection implemented by a computer system which allows the results of the pattern recognition analysis to be communicated to a display controller 34 and a display screen 22. These steps may be implemented by the computer system manufacturer or by the developer of software such as application software which implements the pointing device functionality. This functionality could be provided in the form of software operated by the computer system 10 or it could be provided by a peripheral such as one of the digital cameras 16, 18 or 20.

As shown in Figure 5, the software 52 for controlling pointer position begins upon the receipt of streaming video (block 54) from one or more of the digital video cameras 16-20. In one embodiment, a frame of the streaming video may be selected (block 56) for analysis. The frame may be selected randomly, or at regular intervals or using a selection algorithm.

In addition, a scene change detector may be used to determine when there is a significant change in scene. When a significant scene change occurs, a frame may be captured for subsequent analysis. Scene change detectors are known in the art and may involve an analysis of the pattern of brightness signals determined by the pixels that make up an imaging array inside one or more cameras. For example, the various pixel sensors may provide outputs. If an output is above a certain level it may be considered white and if it is below a certain level it may be deemed to be black. A significant change in the number of white and black outputs can be recognized as a scene change initiating the selection of one frame from the streaming video.

While the present invention has been described with respect to the use of a single frame, a continuing analysis could be done by successively or continually analyzing successive frames.

Once a frame is selected, as indicated in block 56, conventional pattern recognition software may be utilized (block 58) to determine if a particular pattern is reflected by the digital video data stream. This software may recognize a particular preprogrammed image such as the finger pointing image or it may be trained to learn a particular image through cooperation of the computer owner or user.

Alternatively, a distinct object may be associated with the user so that the object may be easily recognized. For example, a distinctly colored ring may be used which can be readily detected. Movement of the ring may be detected as a pointer position command.

At diamond 60, the software checks to determine whether the selected frame contains a pattern matching a predetermined pattern which corresponds to a pointer position command. If not, the flow returns to select another frame.

If a pattern match is detected, the first and subsequent frames are compared (block 62) and a determination is made as to whether there has been a change in position (block 66). If a position change is recognized, a rate and direction of movement of the image are determined. The extent, rate and/or direction of movement can be used to provide a corresponding movement of the pointer (block 67). This is done by sending a signal to the display controller to move the pointer (block 68) on the display screen 22 according to the extent, direction or rate.

The software 78 for enabling the system to calibrate a focus point for pointer position commands is shown in Figure 6. The software 78 may be utilized during a calibration period in order to program the system to recognize the desired inputs. Referring to Figure 6, initially streaming video is received as indicated in block 80. A frame of that streaming video is captured, as illustrated in block 82.

Next, the system is prompted for movement in a defined direction as shown in block 84. For example, an onscreen display may guide the user through the learning process. For example, the onscreen display may first direct the user to show a left cursor position command. The sequence then cycles through each of the cursor command directions. Once the system knows what cursor command is being programmed, it may capture a new (subsequent) frame of video as indicated in block 86. The new (subsequent) frame and the prior frame are compared to determine a difference that amounts to a given cursor command (block 88). A check at diamond 90 determines whether a focus point has been identified. In other words, the system must be able to differentiate the two frames sufficiently to be able to thereafter recognize those differences as a particular pointer position command. If not, the process is tried again. Otherwise, the system saves off the focus point data of the identified focus point, as indicated in block 92.

Referring to Figure 7, the software 79 enables a calibration of speed and direction of pointer position commands. The focus point data of the focus point determined by the software 78 is loaded at block 94. Streaming video is received as indicated at block 96 and a frame is captured as shown in block 98. A focus point is identified such as the user's finger as indicated in block 100 and a movement prompt is provided (block 102). The prompt may

be a message block on the screen asking the user to implement what the user wants to use as a desired movement. A new (subsequent) frame is captured in block 104 and compared to the frame captured in block 98, as illustrated by block 106.

The focus point movement is identified (block 108) and a direction and rate of movement are calculated as indicated in block 110. A correlation factor for x, y and z directions is used to calculate the corresponding rate and direction of movement of the screen pointer (block 112). The screen pointer is then moved as indicated in block 114. The user then may adjust the amount of pointer movement for a given movement of the user's finger, for example through inputs provided by a prompt screen, as indicated in block 116. In addition, the user may provide alternative inputs which could be received as a particular pointer position command. The user is then prompted to indicate whether the user is done in diamond 118. If not, the flow cycles and new commands may be learned as described above. Otherwise the flow is terminated and the information is saved (block 120).

The number of cameras that may be used may be subject to considerable variation. More cameras may result in better 3D imaging. This may allow movements in three dimensions to be recognized as pointer command signals. In addition, camera redundancy may be used to eliminate errors.

While the present invention has been illustrated with respect to a separate camera mounted on the computer, the camera could be integrated into the housing of the computer system itself. In addition, while the invention has been illustrated in connection with cameras sensitive to light in the visible spectrum, infrared detecting cameras could be used as well.

By using streaming video to control pointer position, an electromechanical connection (which may be prone to error or failure) may be eliminated. In addition, the accuracy of the pointing device may be improved, for example, as compared to touch pad pointing devices, because the possibility of incorrect actuation due to dirt or moisture may be eliminated.

While the present invention has been described with respect to a limited number of embodiments, those skilled in the art will appreciate numerous modifications and variations therefrom. It is intended that the appended claims cover all such modifications and variations as fall within the true spirit and scope of the present invention.

What is claimed is:

1. A method for controlling a computer pointer comprising:

receiving a digital video stream;

analyzing said digital video stream; and

controlling the position of the pointer based on the analysis of said video stream.

2. The method of claim 1 wherein said step of receiving a digital video stream includes capturing a digital video image and inputting a representation of said image to said computer.

3. The method of claim 1 wherein said analyzing step involves using pattern recognition software to analyze said digital video stream.

4. The method of claim 1 including extracting a first video frame, and analyzing said video frame using pattern recognition software.

5. The method of claim 4 including extracting a subsequent frame and comparing said first video frame and subsequent frames.

6. The method of claim 1 including determining a direction of movement of an object depicted in said digital video stream.

7. The method of claim 6 determining the rate of movement of said object.

8. The method of claim 7 including detecting a scene change and when a scene change is detected, selecting a new frame and analyzing said new frame.

9. An article comprising a medium for storing instructions that cause a computer to:

receive a digital video stream;

analyze said digital video stream; and

control the position of said pointer based on the analysis of said video stream.

10. The article of claim 9 wherein including instructions that cause a computer to recognize a pattern corresponding to a particular object from said digital video stream.

11. The method of claim 1 further including:
detecting a gesture having a semantic meaning; and
converting said detected gesture into an input for an electronic device;

12. The method of claim 11 wherein converting includes converting said gesture into a pointer control signal.

13. The method of claim 11 wherein detecting a gesture includes detecting gestures having the semantic meaning of yes or no.

14. The method of claim 11 wherein detecting includes developing a video frame of said gesture.

15. The method of claim 24 further including using pattern recognition software to detect said gesture.

16. A system comprising:
a processor;
memory associated with said processor, said memory storing a computer program that causes said processor to:
receive a digital video stream;
analyze said digital video stream; and
control the position of a pointer based on the analysis of said video stream.

17. The system of claim 6 including a plurality of digital video cameras.

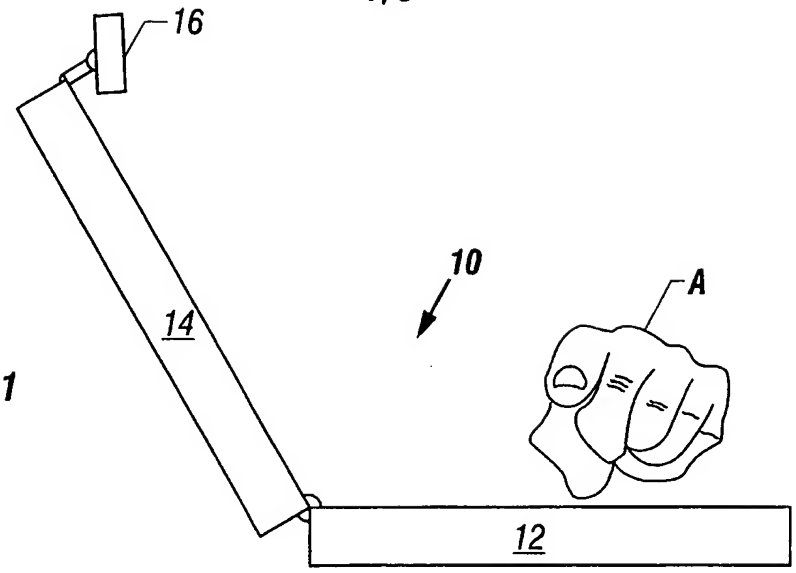

FIG. 1

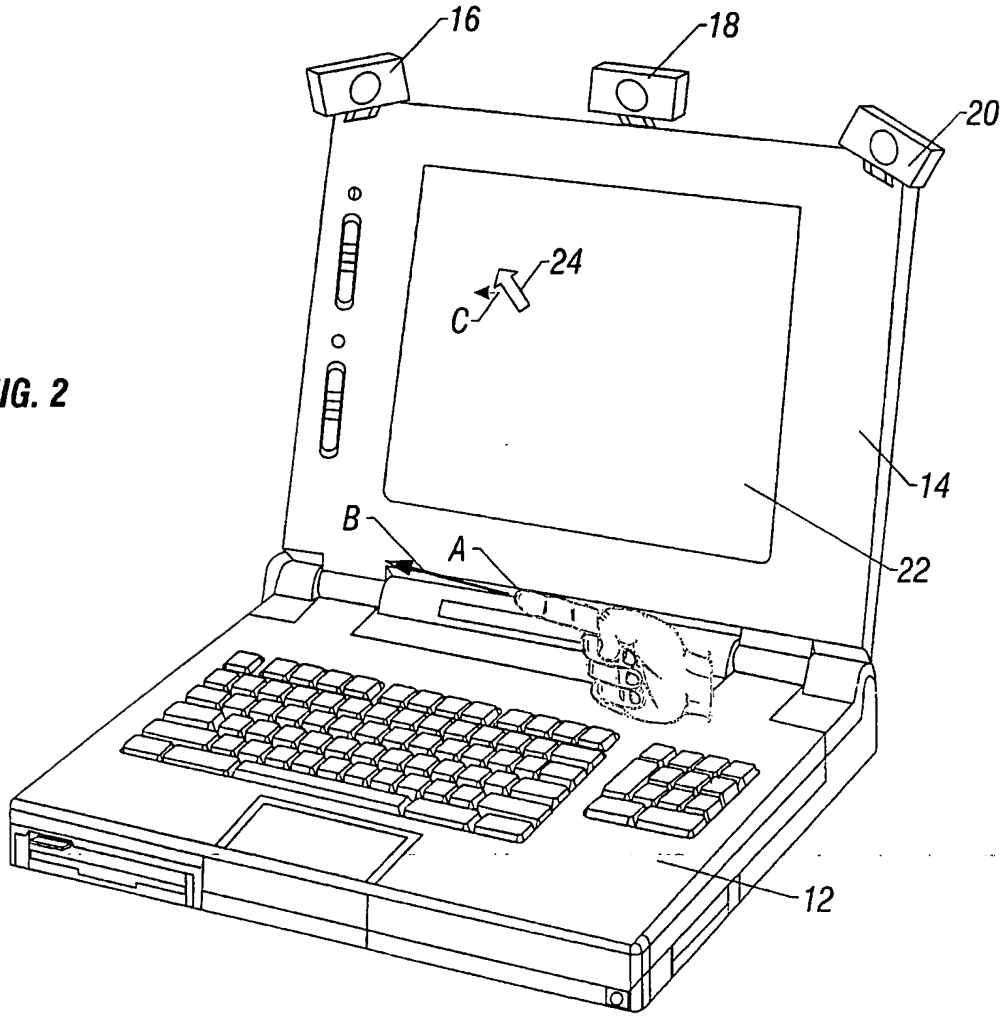

FIG. 2

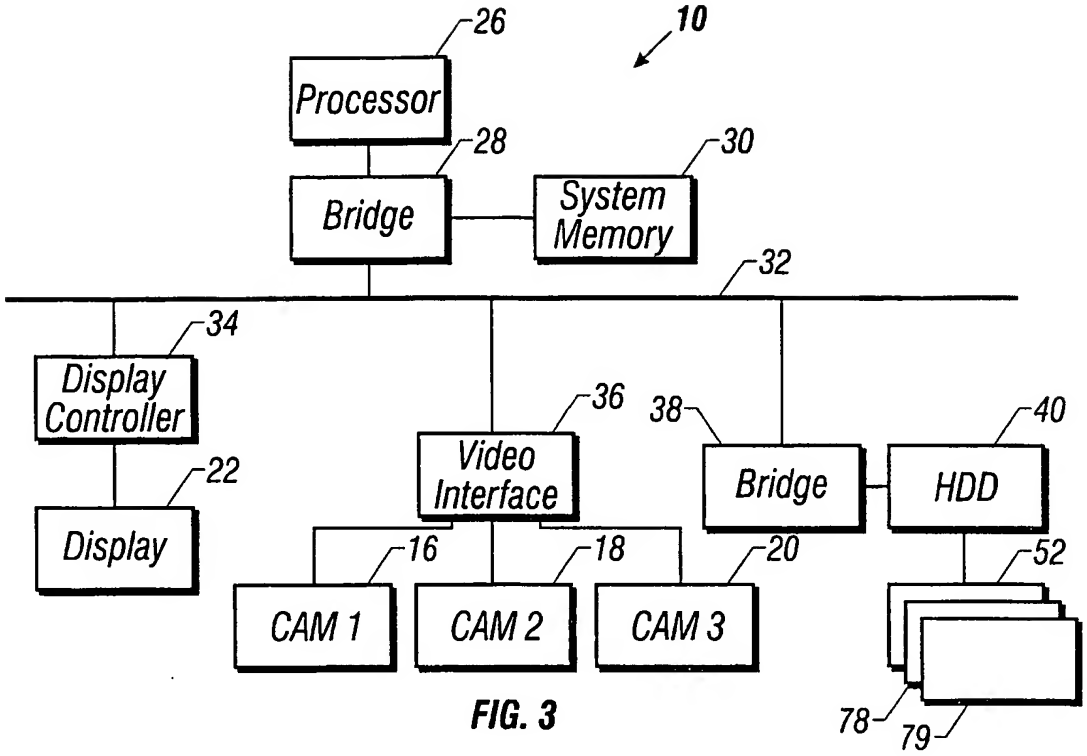
10
26
Processor
28
Bridge
30
System Memory
32
34
Display Controller
22
Display
36
Video Interface
16
CAM 1
18
CAM 2
20
CAM 3
38
Bridge
40
HDD
52
78
79

FIG. 3

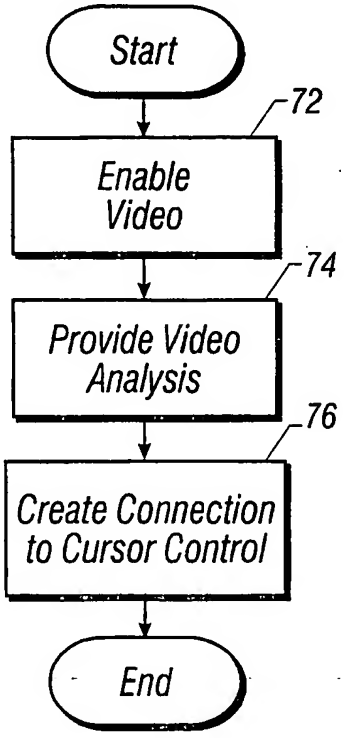
Start
72
Enable Video
74
Provide Video Analysis
76
Create Connection to Cursor Control
End

FIG. 4

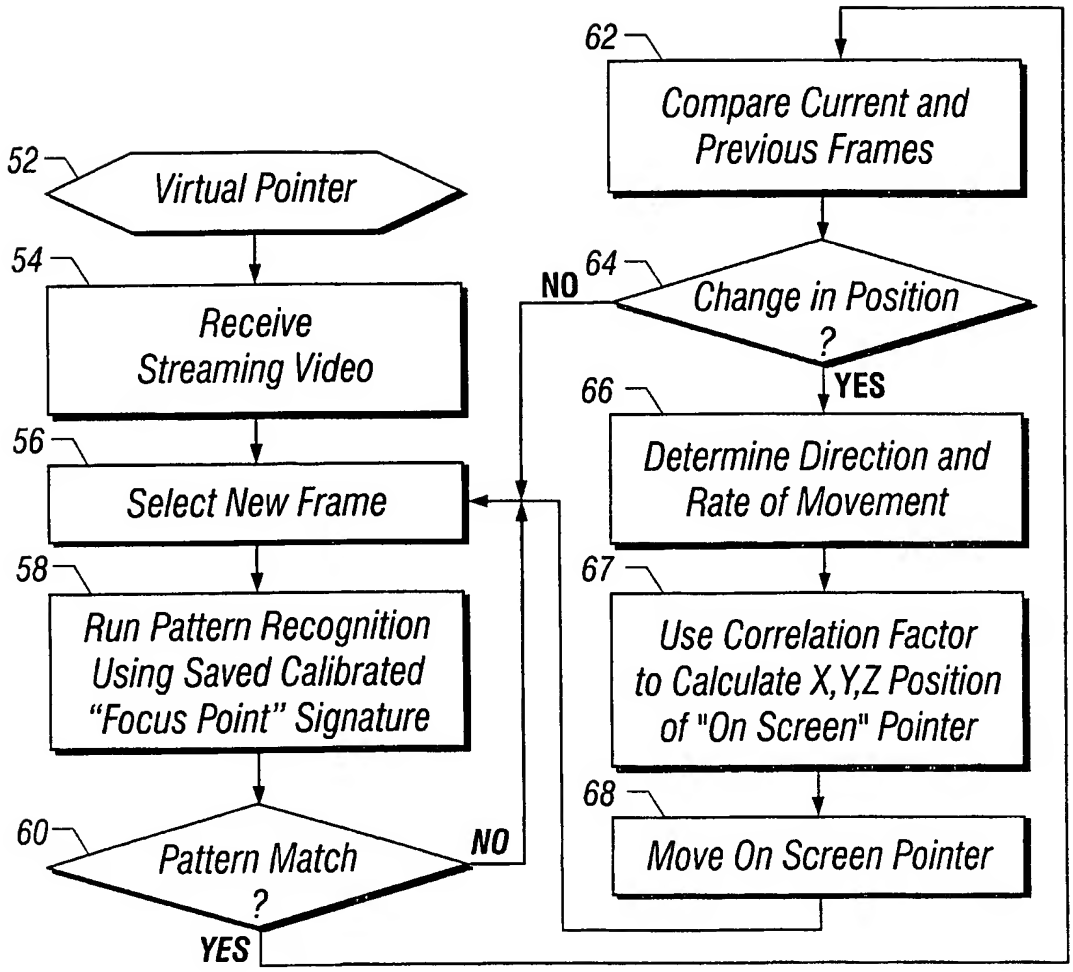
62
Compare Current and Previous Frames
52
Virtual Pointer
64
NO
Change in Position ?
YES
54
Receive Streaming Video
66
Determine Direction and Rate of Movement
56
Select New Frame
58
Run Pattern Recognition Using Saved Calibrated "Focus Point" Signature
67
Use Correlation Factor to Calculate X,Y,Z Position of "On Screen" Pointer
60
Pattern Match ?
NO
YES
68
Move On Screen Pointer

FIG. 5

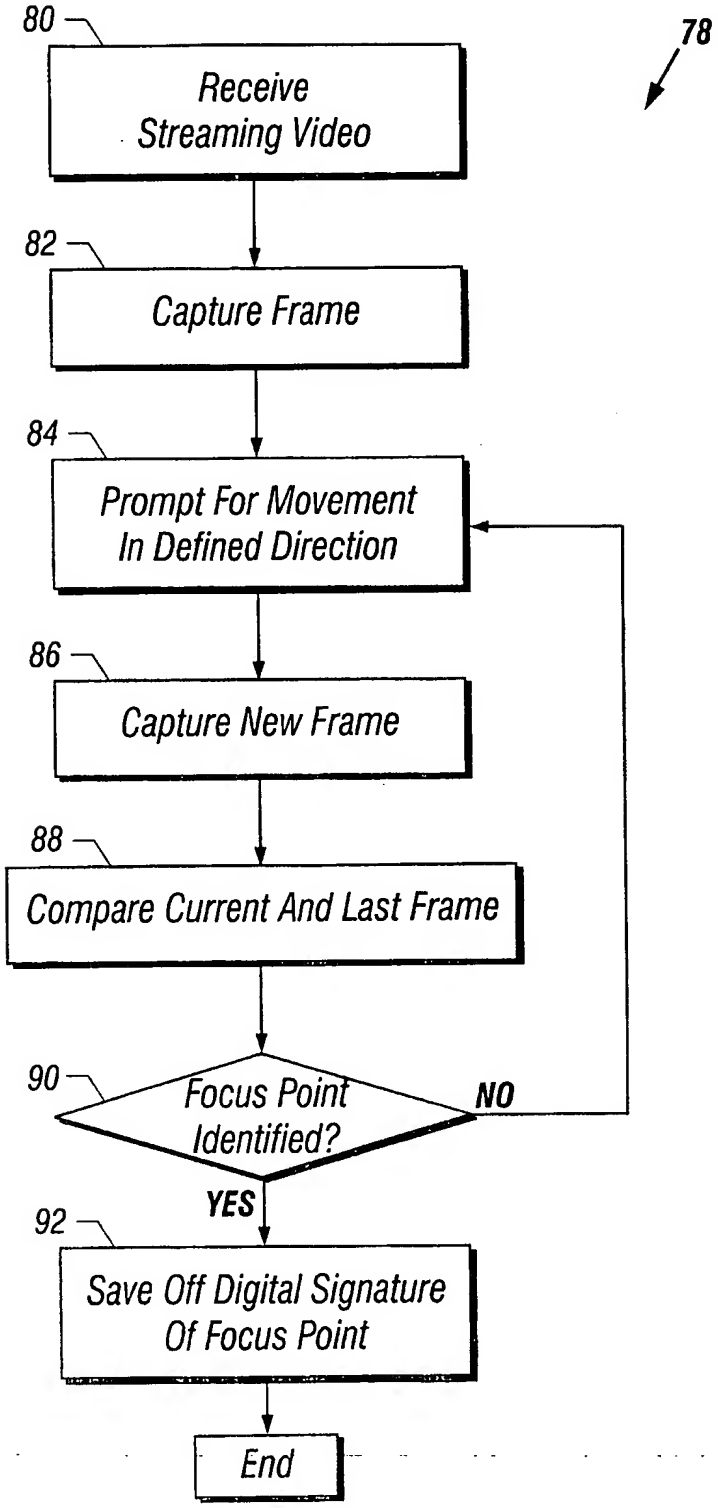
78
80
Receive Streaming Video
82
Capture Frame
84
Prompt For Movement In Defined Direction
86
Capture New Frame
88
Compare Current And Last Frame
90
Focus Point Identified?
NO
YES
92
Save Off Digital Signature Of Focus Point
End

FIG. 6

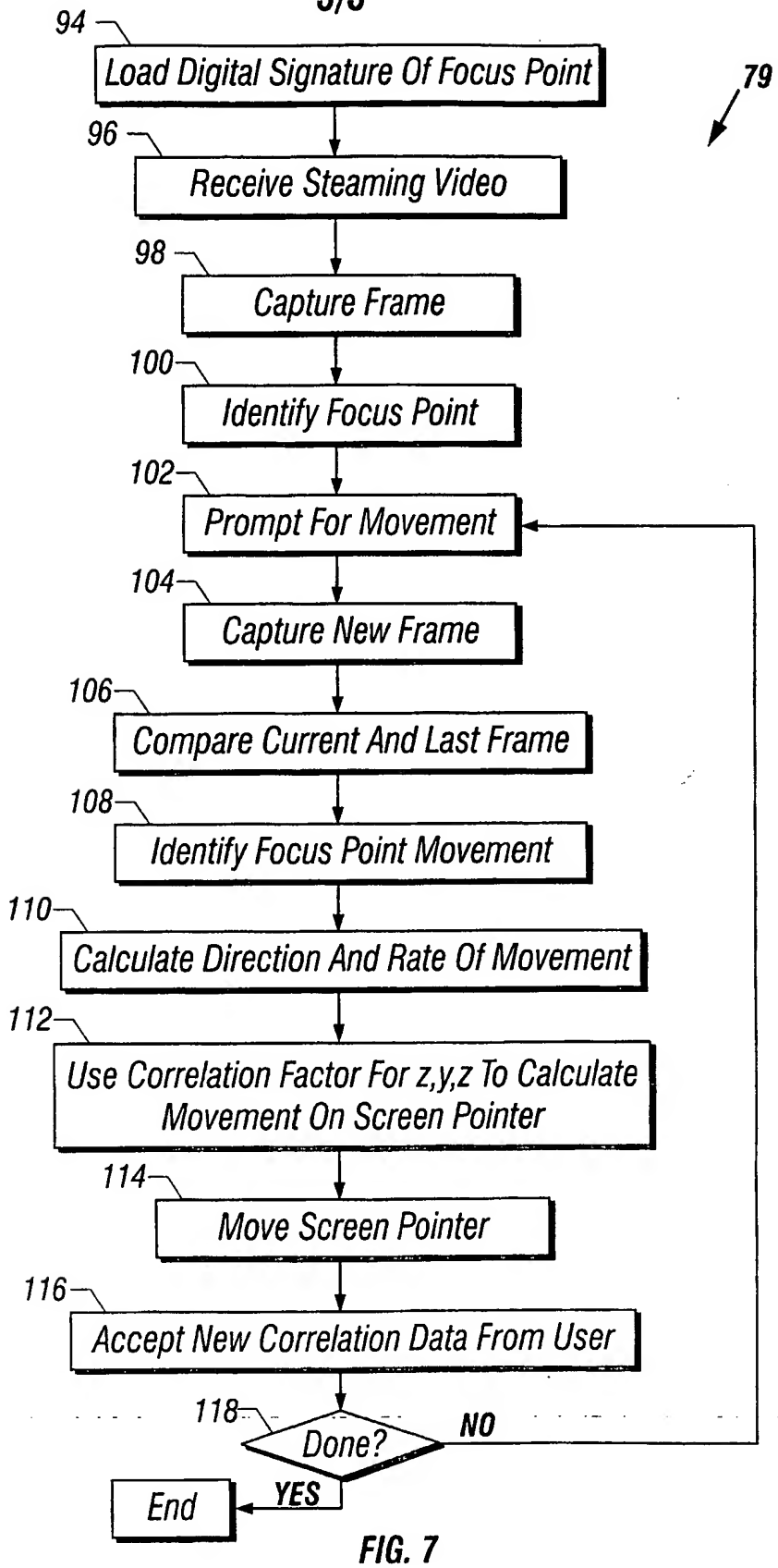
94
Load Digital Signature Of Focus Point
79
96
Receive Steaming Video
98
Capture Frame
100
Identify Focus Point
102
Prompt For Movement
104
Capture New Frame
106
Compare Current And Last Frame
108
Identify Focus Point Movement
110
Calculate Direction And Rate Of Movement
112
Use Correlation Factor For z,y,z To Calculate Movement On Screen Pointer
114
Move Screen Pointer
116
Accept New Correlation Data From User
118
Done?
NO
YES
End

FIG. 7

INTERNATIONAL SEARCH REPORT

Interr nal Application No
PCT/US 99/19521

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 G06K11/08 G06F3/00

According to International Patent Classification (IPC) or to both national classification and IPC

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C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	EP 0 866 419 A (TAKENAKA CORP) 23 September 1998 (1998-09-23) column 18, line 28 -column 22, line 27 column 25, line 9 -column 29, line 25 column 37, line 28 -column 42, line 11 figures 1-4,10A-13,16-18,22A-23	1-13,16, 17
A	---	14,15
X	EP 0 837 418 A (TOKYO SHIBAURA ELECTRIC CO) 22 April 1998 (1998-04-22) page 8, line 7 -page 26, line 12 page 33, line 22 -page 35, line 44 figures 1,2,6-46,74-79	1-7, 9-13,16, 17
A	---	8,14,15
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INTERNATIONAL SEARCH REPORT

Interr nal Application No
PCT/US 99/19521

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication,where appropriate, of the relevant passages	Relevant to claim No.
X	US 5 594 469 A (FREEMAN WILLIAM T ET AL) 14 January 1997 (1997-01-14) column 4, line 66 -column 12, line 24 figures 1-7	1-7, 9-13,16
A		8,14,15, 17

X	US 5 168 531 A (SIGEL CLAUDE) 1 December 1992 (1992-12-01) column 3, line 63 -column 10, line 33 column 12, line 49 -column 13, line 34 figures 1,2,5-12	1-4,6, 9-13,16, 17
A		5,7,8, 14,15

X	US 5 454 043 A (FREEMAN WILLIAM T) 26 September 1995 (1995-09-26) column 5, line 62 -column 11, line 17 figures 1-5	1-4,6, 9-12,16, 17
A		5,7,8, 13-15

X	EP 0 571 702 A (TAKENAKA CORP) 1 December 1993 (1993-12-01) column 3, line 32 -column 7, line 15 figures 1-6	1-4,9, 10,16,17
A		5-8, 11-13

INTERNATIONAL SEARCH REPORT

..ormation on patent family members

Interr nal Application No
PCT/US 99/19521

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
EP 0866419 A	23-09-1998	JP 10326148 A	08-12-1998
EP 0837418 A	22-04-1998	JP 10222285 A	21-08-1998
		JP 10222646 A	21-08-1998
		JP 10177449 A	30-06-1998
US 5594469 A	14-01-1997	JP 2941207 B	25-08-1999
		JP 8315154 A	29-11-1996
US 5168531 A	01-12-1992	DE 69217550 D	27-03-1997
		DE 69217550 T	25-09-1997
		EP 0591412 A	13-04-1994
		WO 9300657 A	07-01-1993
US 5454043 A	26-09-1995	NONE	
EP 0571702 A	01-12-1993	JP 5324181 A	07-12-1993
		JP 5324147 A	07-12-1993
		DE 571702 T	28-04-1994
		EP 0829799 A	18-03-1998

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